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# Transfer of Function Across Members of an Equivalence Class

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A child's presses on response windows behind which stimuli were presented via computer monitor occasionally lit lamps arranged in a column; a present was delivered when all lamps in the column were lit. During the operation of a multiple schedule, the child first learned low rates of pressing in the presence of STAR and high rates in the presence of TREE. Later, in an arbitrary matching task, the child learned to select STAR given wiggly WORM and TREE given BLOCK. When WORM and BLOCK were inserted into the multiple schedule, the low and high rates respectively correlated with STAR and TREE transferred to them. Tests of reflexivity (identity matching) and of symmetry of the arbitrary matching implied that STAR and WORM had become members of one equivalence class, and TREE and BLOCK had become members of another.

In a three-term contingency, a discriminative stimulus sets the occasion on which a response may produce a consequence. The relation between the discriminative stimulus and the response is ordinarily unidirectional. For example, when a green light sets the occasion on which a pigeon's key peck produces food pellets, the pigeon may come to peck the key in the presence of green. But there is no simple sense in which the pigeon may come to green in the presence of the peck.

In the conditional discrimination called arbitrary matching, however, each of the first two terms of the three-term contingency is defined by stimulus properties. First one stimulus is presented as a sample (a response to this stimulus is often required, to increase the likelihood that the organism will attend to the stimulus presentation). Then at least two other stimuli are presented as comparisons; a response to the stimulus that stands in a designated relation to the sample is reinforced, whereas responses to any other stimulus are not. For example, in an arbitrary matching procedure that uses colors and forms, a pigeon's peck on a circle comparison stimulus may produce food given a red sample stimulus whereas its peck on a square comparison stimulus may produce food given a green sample stimulus. Once the pigeon has mastered this conditional matching task, the reversal of this relation can be tested, by asking whether, in the absence of reinforcement, the pigeon will then peck red given circle and green given square (the pigeon does not typically do so: e.g., Lipkens, Kop, & Matthijs, 1988).

This kind of reversibility of terms is a ubiquitous feature of verbal behavior, in which the utterance that is a speaker's response is simultaneously the listener's stimulus and in which words may precede or follow nonverbal events. It is also one property of the relations among stimuli that define them as members of equivalence classes (Sidman, Rauzin, Lazar, Cunningham, Tailby, & Carrigan, 1982).

Stimuli are said to be members of an equivalence class if without specific training they exhibit within arbitrary matching procedures the properties of reflexivity, symmetry, and transitivity. In the reflexivity relation (x → x, as in identity matching), a stimulus is matched to itself. In the symmetry relation (if x → y, then y → x), the positions of sample and comparison are reversible. In the transitivity relation (if x → y and y → z, then

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$x \rightarrow z$), a stimulus that serves as comparison in one instance of matching and as sample in another establishes a matching relation between the sample of the first instance and the comparison of the second.

The functional significance of equivalence classes lies in the possibility that the discriminative functions of one stimulus within such a class will automatically transfer to all of the other members. For example, consider the child who has learned to obey the words "go" and "stop" when crossing with parents at a traffic intersection. (In the technical language of verbal behavior, "go" and "stop" in this example are mands: Skinner, 1957). If the child is then taught that the green traffic light is equivalent to "go" whereas the red one is equivalent to "stop," it would be especially valuable to know whether the differential behavior established with respect to the words will transfer to the traffic lights even without additional instruction. (For discussions of other examples of transfer across equivalence classes, see Lazar, 1977; Wulfert & Hayes, 1988.)

The research presented here is a demonstration experiment designed to show that such transfer can occur. For this purpose, only one instance is necessary, and the experiment therefore involves an N of one. The experiment first established two different rates of responding in the presence of two discriminative stimuli, and then, through an arbitrary matching procedure, made each stimulus a potential member of a different two-member equivalence class. The question was whether the rates of responding would transfer to the other stimulus member of each class, even though these stimuli had never appeared within the rate differentiation procedure.

## METHOD

### *Apparatus and Setting*

The apparatus is illustrated in Figure 1, which shows a child seated before the main experimental panel. The panel was clamped to a desk along one wall of a teachers' area in the Cae Top elementary school, Bangor, North Wales. The area included a telephone, a photocopying machine, and a corner where teachers occasionally came to prepare a cup of tea. On most days the room was not used by teachers during experimental sessions. Occasionally such activities did occur, but when they did so the children were usually thoroughly involved in their procedures and rarely seemed to notice or be distracted by the comings and goings.

The experimental panel was 61 cm wide and 84 cm high, and stood 76 cm above the floor. A metal plate on the panel contained five response windows, each 5-cm square. (Figure 1 shows only the two left windows; the center window and the two right windows are masked by a metal cover; cf. Figure 4). Stimuli could be presented in the response windows by a computer monitor located behind the panel. The monitor was connected to an Apple II computer that arranged experimental contingencies. A microphone fastened at the lower left corner of the panel allowed sessions to be recorded on cassette. A shelf was located behind a 7-cm high by 36-cm wide Plexiglas-covered opening in the upper part of the panel. Presents earned by the child were placed on this shelf (one is shown in Figure 1).

A 46-cm wide by 138-cm high panel was attached at an angle to the right edge of the main panel and extended to the floor. Mounted on it was a column of eight lamps behind 7.5-cm square colored inserts. The order of colors from bottom to top was: red, yellow, blue, white, yellow, blue, white, red. (In Figure 1, the bottom four lamps are lit.) A second panel, 51-cm wide by 156-cm high, was similarly attached to the left edge of the main panel. It included a 10-cm square curtained opening through which a hand puppet (Garfield the Cat) occasionally emerged to interact with the child (see Figure 4). This panel also screened the experimenter(s) and apparatus from the child.

### *Subject*

Several children from the Cae Top School served in variations of the procedures reported here. All of the children who participated were fluent in English (some were bilingual Welsh and English speakers). Only three children completed both the rate differentiation and matching components of the experiment. Of these, one showed a position preference that precluded interpretation of the transfer results. For another, a procedural error during the first transfer session, in which transfer did not occur, was followed by a demonstration of transfer in a

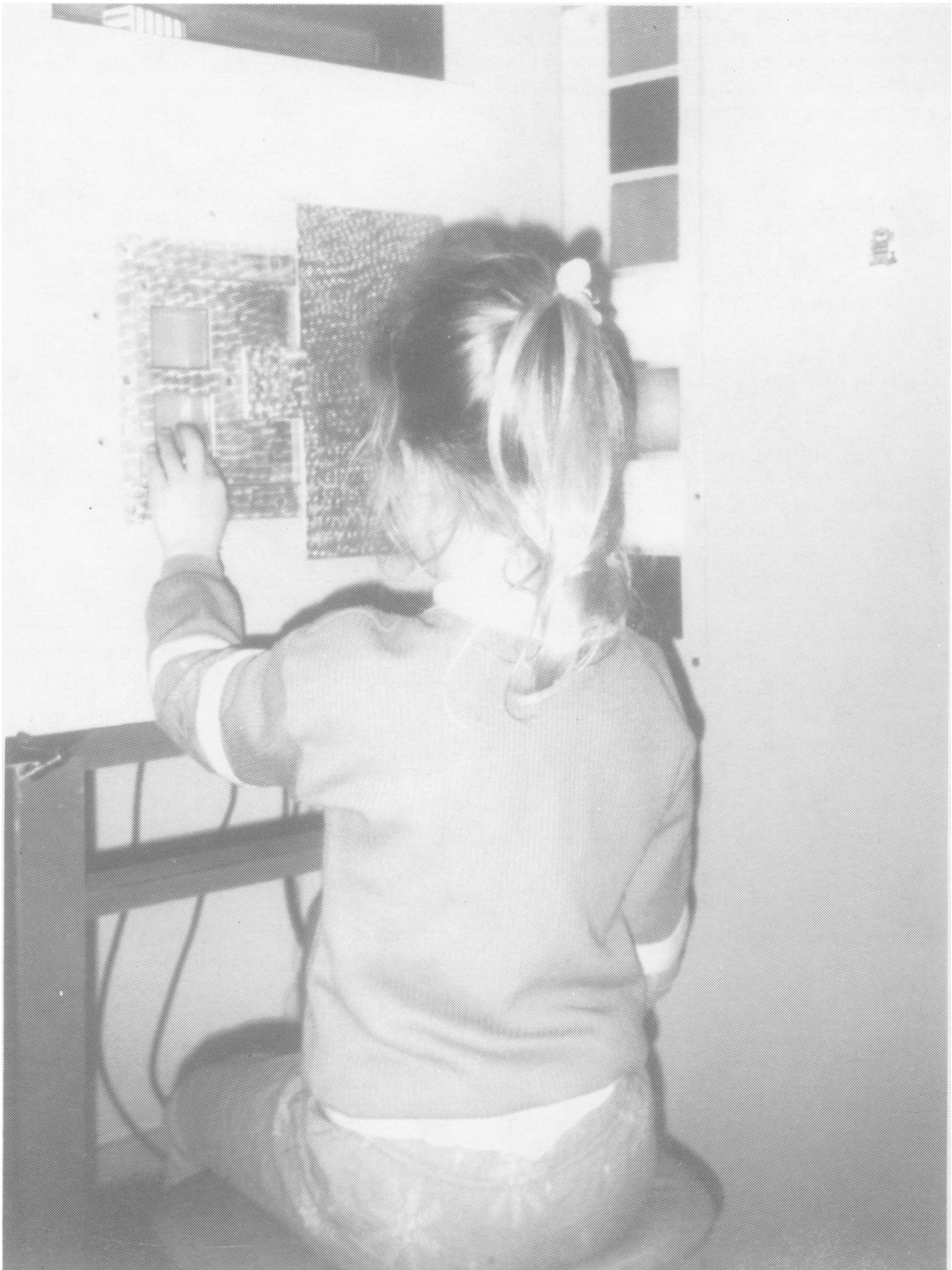

Fig. 1. A child responding during one of two multiple-schedule components, with stimuli presented by a computer monitor behind the two response windows. A present is visible to the child on the upper shelf. The four bottom column lamps have been lit; another present will be delivered when the child has lit the remaining four.

subsequent correctly scheduled transfer session. Thus, only one child successfully completed the entire procedure. This account presents the data from that child, a boy aged 5 yr 5 mo at the start of the experiment who will here be called Adam.

*Procedure*

The general procedure is illustrated schematically in Figure 2. First, a multiple schedule was used to establish slow responding in the presence of STAR and fast responding in the presence of TREE. Then, in an arbitrary matching procedure, matching of STAR to WORM and of TREE to BLOCK was taught. Once the matching was established, WORM and BLOCK were inserted into the multiple schedule to determine whether the respective slow and fast rates maintained in the presence of STAR and TREE would transfer to WORM and BLOCK. Finally, the matching procedure was used to test for symmetry of the arbitrary match (e.g., matching of WORM to STAR) and for reflexivity (identity matching).

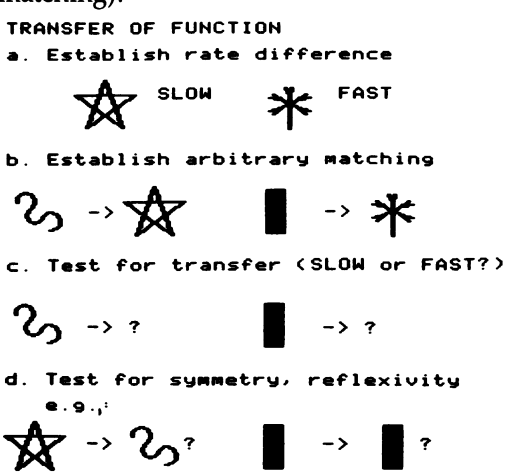


Fig. 2. Procedural outline: (a) different multiple-schedule response rates are established during STAR and TREE; (b) matching of STAR - WORM and of TREE - BLOCK is established; (c) transfer of rates is tested by substituting WORM and BLOCK for STAR and TREE in the multiple schedule; and, (d) tests of symmetry and reflexivity examine whether the relations STAR - WORM and TREE - BLOCK exhibit some properties of equivalence classes.

*Initial sessions.* Sessions were conducted on a semi-regular basis, usually beginning between 9:30 and 10:30 am and varying with other scheduled school activities and an occasional absence. On the day of the first session, Adam was escorted from his classroom to the experimental area by a UCNW student who assisted in the procedures. There he was given a scrapbook and was helped to write his name in it. Next he was shown sheets of decals with a broad selection of pictures and a "treasure chest," a box containing a variety of small toys, drawing materials, etc. He was asked if he would like to play a game in which he could win pictures for his scrapbook and a chance to pick out something from the treasure chest. Upon his assent he was shown to the stool facing the experimental panel, where Garfield the Cat, in hand-puppet form, emerged from the curtained opening in the left panel (see Figure 4). Garfield introduced himself, asked Adam's name, and then explained that he could earn presents by lighting up all of the lamps on the right panel. The lamps were then lit one by one, starting at the bottom. As each new lamp was added, it and the previously lit ones blinked five times at a rate of 5 per second before remaining continuously on; each blink was accompanied by a computer beep the pitch of which increased with the height of the lit lamps in the column. This sequence of events as lit lamps were added to the column remained in effect throughout the experiment.

When all the lamps of the column were lit, one of the small boxes that served as presents was inserted on the upper shelf. The lamps blinked until shortly after the present was placed and then went out. Garfield called the present to Adam's attention, and then a star appeared in the upper of the two available response windows. Garfield, telling Adam to watch, pressed that window and the bottom lamp turned on. Garfield then said, "Now you try." Adam pressed and the second lamp turned on. Each of his next presses lit another lamp until the entire column was again lit, at which point Garfield announced the delivery of another present and then withdrew. At this point, the multiple-schedule procedure was instituted.

*Multiple schedule.* Figure 3 shows the stimulus configurations in the two components of the multiple schedule: STAR on the top window in component 1 and TREE on the bottom window in component 2. The components were presented in alternation, with sessions beginning with component 1 and ending with component 2. The two locations made it possible to determine if Adam was attending to the visual stimuli even when response rates in the two components were roughly equal (note, however, that following of stimulus location showed whether responding was controlled by the window that was lit; it did not guarantee control by the stimulus that appeared in that window). In later sessions, the order of components 1 and 2 was occasionally reversed (see reversal symbols in Figure 7).

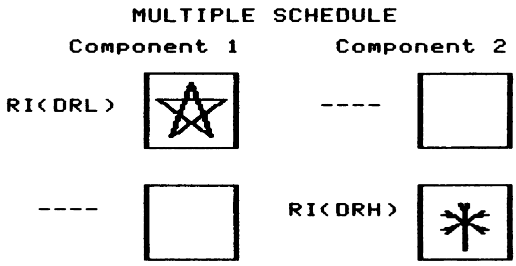


Fig. 3. Multiple-schedule stimuli as presented by computer monitor. Presses produced consequences according to a random-interval schedule designed to differentially reinforce low rates during component 1 (STAR, top window) and high rates during component 2 (TREE, bottom window).

Each component lasted 60 s, excluding the fixed periods during which the lamps blinked as new ones were added to the column and the variable periods when presents were delivered (the latter were under experimenter control to allow for Garfield's entrances and exits, and to insure that Adam attended to the delivery of each new present). During these periods and during 5-s periods between the multiple-schedule components, the stimuli behind the response windows were off, presses on the response windows had no consequences, and schedules did not operate.

Multiple-schedule sessions typically lasted 3 to 5 pairs of components (10 to 20 min), though one session was interrupted after 2 pairs of components and another was extended to 6 pairs. At the end of each session, Adam selected one decal for his scrapbook for each present he had earned and also chose an item from the treasure chest.

During the first 5 sessions (21 pairs of components), a random-interval (RI) schedule operated in both components of the multiple schedule. Its value was increased from RI 5-s in the first session to RI 8-s in the second and third sessions to RI 10-s in the fourth session and thereafter. Each second, with a probability given by the reciprocal of the RI value in s, an increment of 1.0 was added to available setups (e.g., for RI 10-s, $p = .10$), where each setup corresponded to the eligibility of a response to produce a consequence. If at least one setup was available, the next press on the appropriate window produced a consequence (lit the next lamp in the column) and reduced the available setups by 1.0. Within a session, setups accumulated at the end of one component were saved until the start of the next component of that type (e.g., STAR to STAR).

This arrangement differs from those in which interval timing stops after a single setup in two ways: latencies from the scheduling to the production of a consequence do not accumulate, thus making the rate of obtained consequences less likely to deviate substantially from the rate of scheduled consequences; and two or more responses in a row can produce a consequence if more than one setup has accumulated. Overall, the actual delivery of consequences was close to the 6 lamps per 60 s component specified by the RI 10-s schedules; thus, given 8 lamps to be lit in the column, six presents were delivered, on the average, in a session of four pairs of components.

In session 6 and thereafter, the schedule in component 1 (STAR) was RI 10-s arranged for completion of a differential reinforcement of low rate (DRL) contingency, and that in component 2 (TREE) was RI 10-s arranged for completion of a differential reinforcement of high rate (DRH) contingency. Both the DRL and the DRH contingencies were based on responding during overlapping 2-s time intervals sampled once per second. In the RI(DRL) component, a response was eligible to produce a consequence if a setup was available and N or fewer responses had occurred during the most recent 2-s time sample. In the RI(DRH) component, a response was eligible to produce a consequence if a setup was available and N or more responses had occurred during the most recent 2-s time sample.

The initial DRL and DRH values were set at the integer number of responses closest to Adam's mean rate of pressing in the prior RI session. The plan was to gradually spread these values apart so as to produce a rate during the RI(DRH) component two to four times higher than that in the RI(DRL) component. Over about the next forty pairs of components, during which various values of N were arranged (in most sessions, 1 in the DRL component and 3 in the DRH component), no separation of response rates occurred. These sessions often ended with several uncollected setups in one or both components, and brief periods during which either DRL or DRH contingencies were satisfied, thereby lighting lamps, were typically not followed by continuation of the performance that had satisfied those contingencies.

*Modelling and verbal behavior.* This insensitivity to the DRL and DRH contingencies had consistently been observed with other children in this procedure over even longer exposure to these schedules (cf. Bentall, Lowe, & Beasty, 1985; Catania, Shimoff, & Matthews, 1989; Lowe, Beasty, & Bentall, 1983). Given this outcome, two interventions were arranged in an attempt to produce differential rates of responding. The first provided an opportunity for modelling or vicarious learning. Garfield appeared at the beginning of a session (following component 60) and announced "I'm a clever fellow. Watch how I play the game." Garfield then responded through two pairs of components, pressing STAR slowly and TREE quickly and therefore lighting lamps and producing presents. This produced a rate difference in Adam's pressing, but that change was transient even though Adam had collected presents at a higher rate during it.

After component 80, Garfield began to appear during an extended intercomponent interval that followed each component pair. During that time, he asked Adam questions about playing the game that were designed to lead Adam to say that STAR worked best when pressed slowly and TREE worked best when pressed fast (e.g., Garfield: "Adam, how do you think the tree works? Does it work better when you press it fast or when you press it slow?" Adam: "Fast." Garfield, excitedly: "Oh, I think that's right. Why don't you try that when you play the game"). This procedure might be regarded as a combination of verbal prompting, instruction, and/or a variety of verbal shaping in which the reinforcing consequence is provided by the behavior of the listener (Greenspoon, 1955; cf. Catania, Matthews, & Shimoff, 1982); it continued through three sessions (13 component pairs), during which a rate difference emerged. Garfield appeared for an occasional reminder question and comment over the next several sessions, and the rate difference was maintained thereafter. (At this point, in the technical language of verbal behavior the respective low and high rates might be treated as tacts of STAR and TREE: Skinner, 1957.)

*Arbitrary matching.* Once a reliable rate difference was established, matching sessions were arranged in irregular alternation with multiple-schedule sessions. Matching sessions usually began in the early afternoon. Session durations were variable, depending on the time for which Adam was available and other uncontrollable circumstances, and lasted no more than 15 minutes. The first few sessions consisted of about 80 trials each, after which they were gradually reduced to about 36 trials each. At the beginning of the first matching session Adam was told that he would be playing a new kind of game. In matching sessions, the mask covering three of the five response windows was removed. The arrangement is illustrated in Figure 4.

In each trial, the sample stimulus was presented on the center window. One press on this window turned on three comparison stimuli (cf. Sidman, 1987), randomly positioned from trial to trial on the four outer windows. A press on the window designated as a match added a lit lamp as a consequence (and, as in the multiple schedule, a present when the whole column was lit). Figure 5 shows sample configurations of the three arbitrary matches. The multiple-schedule stimuli, STAR and TREE, served as two of the three comparison stimuli. With WORM as sample, STAR was designated the matching comparison, and with BLOCK as sample, TREE was designated the matching comparison. The third matching set included as sample and matching comparison two stimuli neither of which had appeared in the multiple schedule: LINES as sample and BALL as matching comparison.

Trials were separated by a 3-s intertrial interval. Each press on a window with a designated matching stimulus produced a consequence. If a press occurred on any other window, the trial ended and trials with that sample stimulus but with changing

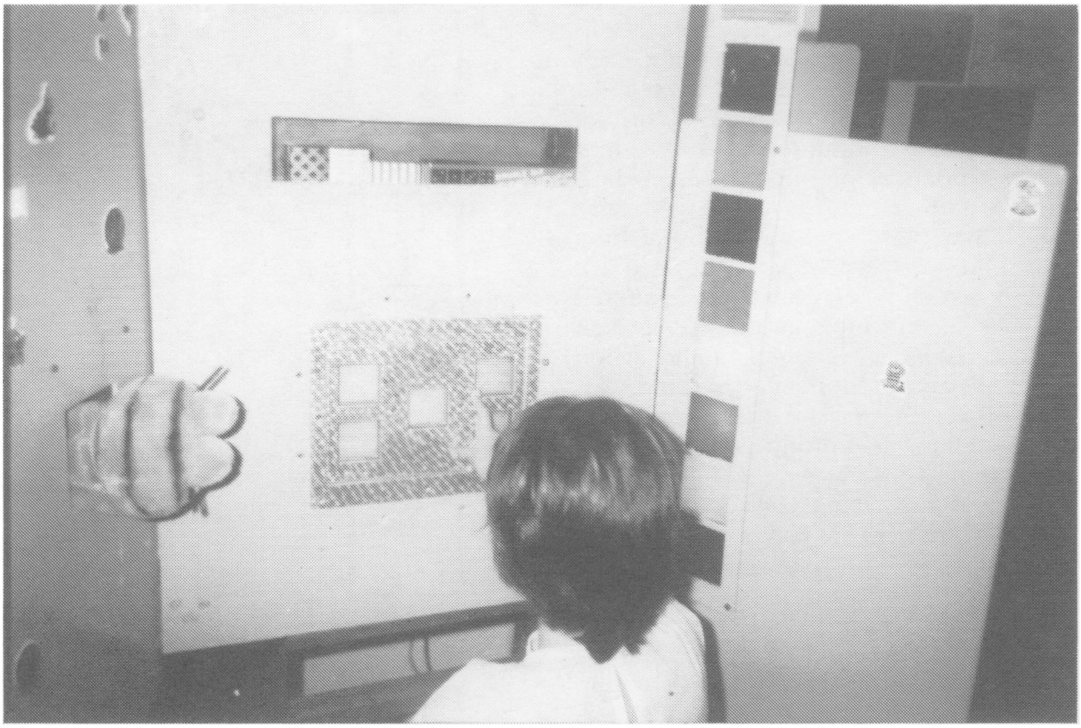

Fig. 4. A child responding in the five-window matching procedure. The child has accumulated several presents in the top window, and four column lamps are currently lit. The child is conversing with Garfield the Cat, who has emerged from a curtained window on the left.

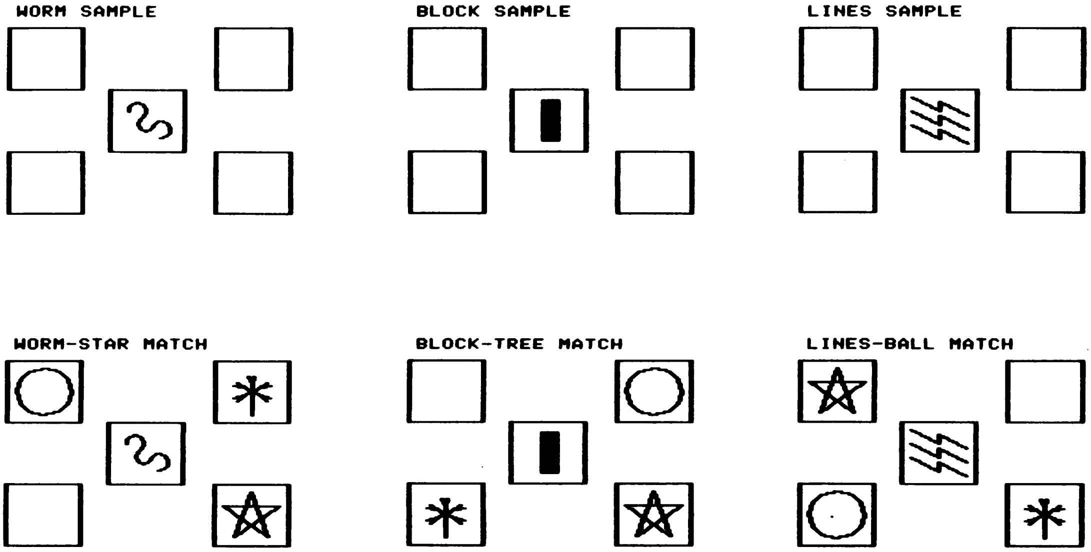


Fig. 5. Three examples of arbitrary matching stimuli. The sample first appeared in the center window (top row). A press on that window turned on the three comparison stimuli in varying positions from trial to trial with the remaining window blank (bottom row).

positions of the comparison stimuli were repeated until three matches had occurred or to a maximum of 10 trials, whichever came first. Trials were also terminated if no comparison press had occurred within 15 s. Each of the three trial types occurred four times, randomly permuted, over each block of twelve trials, excluding repeated trials that followed nonmatching responses. Experience with other children in this procedure had shown that acquisition of matching developed slowly if at all, and after five sessions in which percent matches remained low, a verbal intervention was introduced on a single trial. Garfield emerged and, when the sample appeared, pointed to it and said, "See this one?" After Adam's press on the sample window had produced the comparison stimuli, Garfield pointed again at the sample and said, "Which one goes with this one?" Percent matches rose to 100% by the next matching session and remained relatively high thereafter.

*Transfer test.* After several sessions with consistent rate differences in the multiple schedule and better than 90% matching in the matching procedure, two transfer tests were arranged in the context of the multiple schedule. After a standard pair of components, WORM was substituted for STAR and BLOCK for TREE in two pairs of components. In the second transfer session, the locations of WORM and BLOCK on the top and bottom windows were also reversed. During all transfer sessions, the RI 10-s schedule continued to operate, but without DRL or DRH contingencies.

*Reflexivity and symmetry tests.* After the transfer sessions, a matching session was arranged in which Garfield told Adam that the lamps would not light, but that he should play the game to earn presents that would be given to him at the end of the session. In this session, the matching sets changed on every trial without regard to the accuracy of Adam's matches. A block of twelve standard trials was followed first by a reflexivity test, twelve trials of identity matching using the arbitrary matching stimuli, and then by a symmetry test, twelve trials in which the samples and matching comparisons of the original procedure were reversed. Figure 6 provides examples of sample and comparison configurations from both the reflexivity test (top) and the symmetry test (bottom).

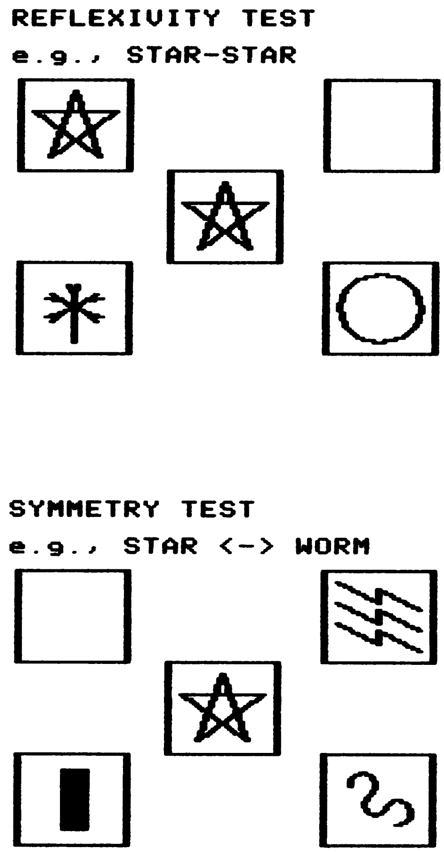


Fig. 6. Examples of sample-comparison arrays in the reflexivity test and in the symmetry test.

## RESULTS

The data are summarized in Figure 7. Through the first 60 pairs of components in the multiple schedule (bottom frame), the RI(DRL) and RI(DRH) schedules did not produce a systematic rate difference in the presence of STAR and TREE. The modelling intervention after component 60 produced a transient rate separation. After component 80, however, the verbal intervention produced a rate separation that was consistently maintained, despite some variability in absolute rates, throughout the remainder of the experiment. The occasional sessions with reversed components showed that component order was not an important determinant of response rates.

The matching procedure began after 24 multiple-schedule sessions (110 pairs of components). Percent matches declined to 28% over the first five matching sessions (top frame), after which the verbal intervention

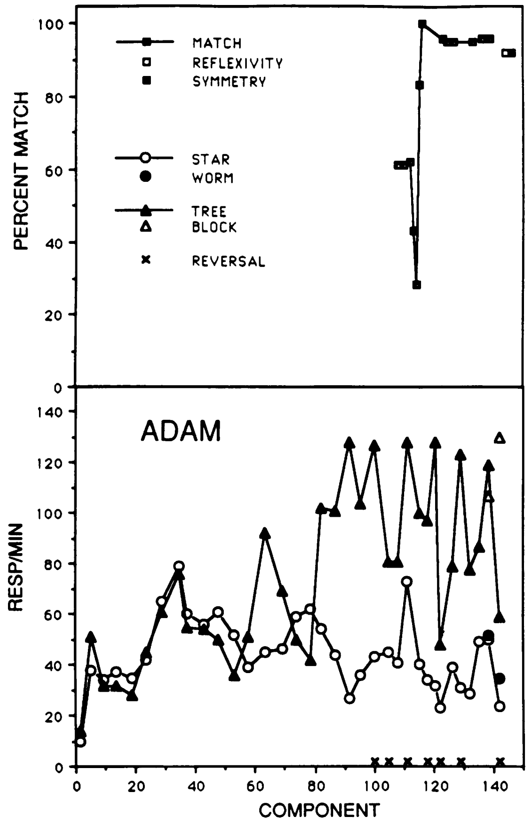


Fig. 7. Response rates over multiple-schedule components and percent matches during arbitrary matching for Adam (aged 5 yr 5 mo at experiment start). Multiple-schedule data (bottom frame) represent single sessions; reversals of component order are shown by x's. Matching-session data (top frame) are plotted directly above data from the multiple-schedule sessions that immediately preceded them. Response rates during transfer (WORM and BLOCK) were comparable to those for equivalent multiple-schedule stimuli (STAR and TREE); percent matches in reflexivity and symmetry tests were comparable to those during standard matching.

was followed by a session of perfect matching (100%) in the seventh matching session. Matching remained at 95% or better for the remainder of the experiment.

In the tests of rate transfer, response rates in the presence of WORM and BLOCK were similar to those previously maintained respectively in the presence of STAR and TREE. Furthermore, the second transfer session began with a reversal in the order of components 1 and 2, followed by WORM and BLOCK in reversed locations (i.e., TREE on bottom, STAR on top, WORM on bottom, BLOCK on top). Thus, this test provided the first occasion for bottom key low rates and top key high rates, as well as the first occasion on which two low-rate stimuli (i.e., STAR and WORM) occurred in immediate succession within a single session. Nevertheless, rates in the presence of WORM and BLOCK were comparable to those in the first transfer session.

After the verbal intervention, Adam occasionally said "Star slow" or "Tree fast" even in Garfield's absence. At one point during the first transfer session, he said "That's slow" when WORM was presented, and "That's fast" when BLOCK was presented.

The reflexivity and symmetry tests followed the tests of rate transfer, and were conducted without the usual consequences (Adam was given presents after the experiment was concluded). In both cases, Adam made eleven out of the twelve possible matches (92%).

## DISCUSSION

The present experiment represents nothing more than a demonstration. It shows that when one stimulus has served as a sample and another as a comparison in an arbitrary matching procedure, a discriminative function of the latter stimulus may transfer to the former without additional training. In other words, stimuli that were members of an equivalence class also became members of a functional class (Sidman, Wynne, Maguire, & Barnes, 1989). Simply to show that something is possible, an N of one is sufficient. Nevertheless, the demonstration has some serious limitations, and it is appropriate to discuss them before considering some implications.

One assumption implicit in the demonstration is that transfer would not have occurred with a nonverbal and/or nonhuman subject (cf. Devaney, Hayes, & Nelson, 1986). The available data on schedule performance and matching in the pigeon, for example, suggest that it would fail such a transfer test given histories establishing comparable differential response rates and levels of arbitrary matching. But a transfer test closely paralleling that in the present demonstration is not available in the literature and would be relevant to conclusions about the prerequisites for transfer of discriminative function.

Another issue is that the status of STAR-

WORM and of TREE-BLOCK as equivalences classes was assessed only by tests of reflexivity and symmetry. Two rather than three stimuli were used in the demonstration because of limitations of time (the research ended two days before the close of the Cae Top school for summer holidays), and at least three stimuli are necessary for a test of transitivity. (Other possibilities arise if responses are admitted as terms in these relations, as when S1 → S2 and S2 → R yields S1 → R, but consideration of such cases is beyond the scope of the present treatment.)

While acknowledging these limitations on the demonstration, it can also be argued that reflexivity and symmetry are more critical to equivalence classes than transitivity. The grounds are that a case can be made for transitivity relations within the performances of nonverbal nonhuman organisms (e.g., as in higher-order conditioning and in chaining procedures: cf. Straub & Terrace, 1981), whereas corresponding evidence for reflexivity and symmetry is at best controversial (e.g., Hayes, 1989; McIntire, Cleary, & Thompson, 1989; Saunders, 1989).

The transfer test also followed only one of two possible orders of the stimuli used in the arbitrary matching task. The stimuli of the multiple schedule appeared as comparisons. But what if TREE and STAR had been the samples and WORM and BLOCK had been the comparisons? If the formation of equivalence classes is the basis for transfer of function, the position of the multiple-schedule stimuli in the matching procedure should make no difference, but a separate procedure would be needed to demonstrate transfer under those conditions.

Finally, and perhaps most important, verbal behavior was involved at several points in the multiple-schedule and matching procedures, but its role in each of the performances and in the transfer test has yet to be analyzed. Verbal interventions were included in producing differential response rates and in producing high levels of arbitrary matching, and relevant verbal behavior accompanied the transfer of response rates in the transfer test.

A central question is whether verbal behavior is a prerequisite for the demonstrated transfer of function, or whether the properties of equivalences are instead in some way a prerequisite for verbal behavior. The priority of verbal behavior is suggested when stimuli seem to become members of an equivalence class only after they have come to be called by a common name. On the other hand, if naming has this function it can do so only because the relations between the names and the stimuli already have the properties of equivalence classes. It is not sufficient to demonstrate a correlation between verbal behavior and equivalences (e.g., Devaney, Hayes, & Nelson, 1986), because a correlation does not establish a causal direction.

Dugdale and Lowe (in press) have argued that this apparent contradiction can be resolved by distinguishing between at least two kinds of equivalences: stimulus-response (i.e., naming) and stimulus-stimulus equivalence relations. The former may be necessary to produce the latter. According to this account, naming is, in turn, a development from simpler forms of verbal behavior (e.g., manding and tacting); like these forms, it is established by the practices of the verbal community.

The issue rests in part on the definition of verbal behavior. For example, if tacting and manding are regarded respectively as terms for stimulus control and contingency control as they are manifested in verbal behavior, then they cannot be defining properties of verbal behavior because both are properties of nonverbal behavior as well.

On the grounds that naming differs from tacting, Catania (in press) has argued that equivalences may be implicit among the properties that set the occasion for this term in its colloquial usage. According to this account, it appears to follow both that equivalences are a prerequisite for verbal behavior and that verbal behavior is a prerequisite for equivalences, and the resolution of the problem may therefore lie with a third alternative: that verbal behavior and equivalences are two different facets of a single behavioral competence. If so, future analyses may best be directed to discovering the contingencies that produce it; presumably they are both ontogenic and phylogenic.

To the extent that the stimuli within them have common functions, equivalence classes have the special properties of higher-order classes of behavior. Other examples are generalized imitation (Baer, Peterson, & Sherman, 1967; Gewirtz & Stingle, 1968), rule-governed behavior (Skinner, 1969), and say-do correspondences (Risley & Hart, 1968). These higher-order classes may be related to each other through equivalences.

For example, the contingencies that may shape correspondences between saying and doing are necessarily more complex than those that operate separately on the saying and on the doing (cf. Baer, Detrich, & Weninger, 1988; Matthews, Shimoff, & Catania, 1987). Nevertheless, the symmetry implicit in these verbal functions is similar to that in equivalence classes. Doing may precede saying, as in describing past behavior, and saying may precede doing, as in keeping a promise.

Furthermore, once saying and doing have become members of an equivalence class, changes in one should be accompanied by changes in the other. To the extent that the control of doing by saying in rule-governed behavior (Skinner, 1969) may parallel the development of equivalence relations between what is done and what is said about what is done (e.g., Bentall & Lowe, 1987; Catania, 1986; Catania, Shimoff, & Matthews, in press), equivalences may be involved in the genesis of rule-governed behavior. It may be relevant that the transfer of fast responding from TREE to BLOCK was accompanied by the transfer of Adam's verbal report, "That's fast."

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